

Geological factors effecting slope instability in the Virginia Coastal Plain: Observations from the 2018 Nottoway Lane Rotational Landslides, King William County

Anne C. Witt*

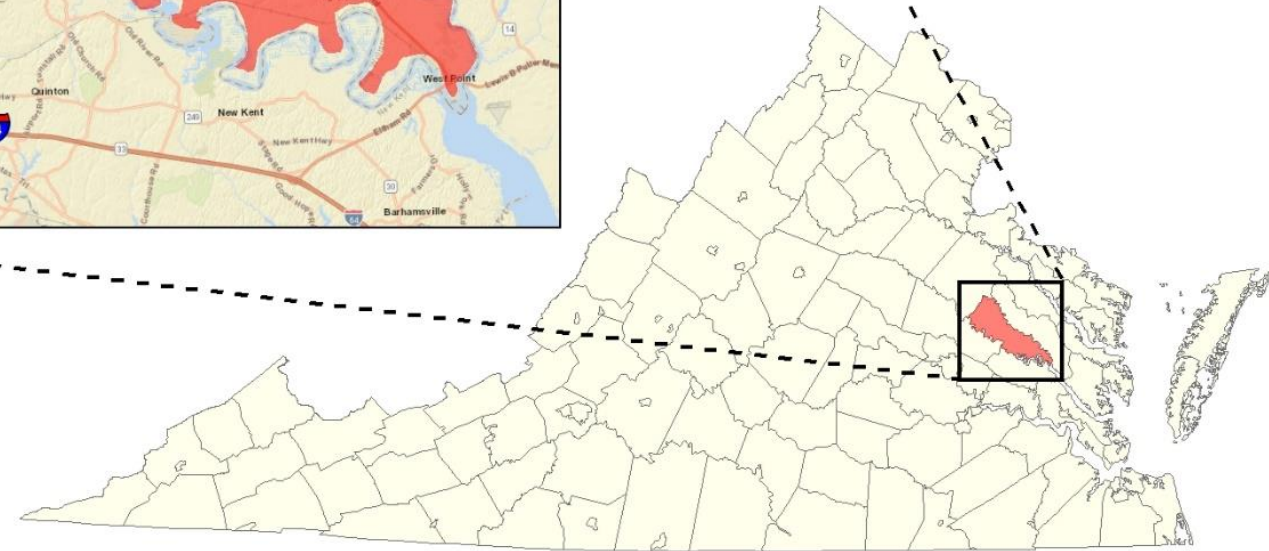
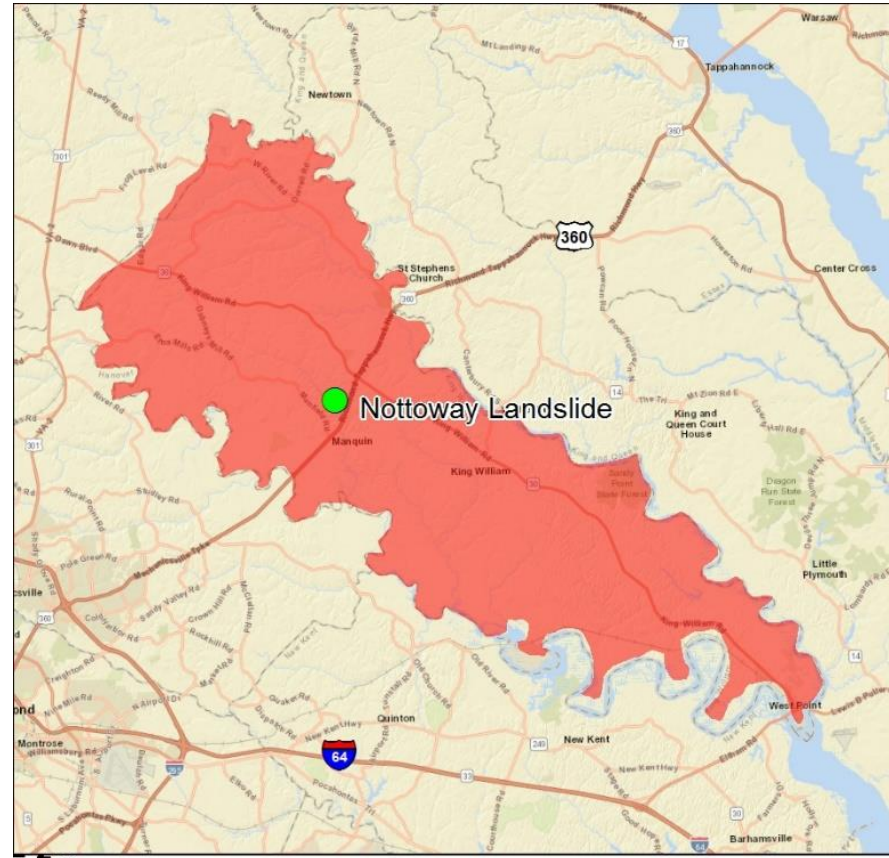
Marcie E. Occhi

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Division of Geology and Mineral Resources

April 18, 2019



- Based on news reports, the slide occurred in the early morning hours of June 3
 - May/June 2018 had been particularly wet – monthly precipitation totals were 150-300% greater than normal
 - Rain gauge 6-miles to the east received 3.9-inches in 24-hours between June 2-3
 - Several NWS flood watches and warnings issued in the County
- First reported to King William County Building Dept. on June 19



- DGMR was first alerted to the landslide on June 19 as a request for assistance from VDEM and the King William Dept of Emergency Management
- First reported as a sinkhole behind two houses at 360 and 362 Nottoway Lane
- Both homes were condemned on June 19





June 19, 2018



June 25, 2018

- King William EM reported on June 25 that slumping and cracking was continuing uphill towards the houses
- DGMR did a preliminary assessment on June 27 to confirm it was a landslide

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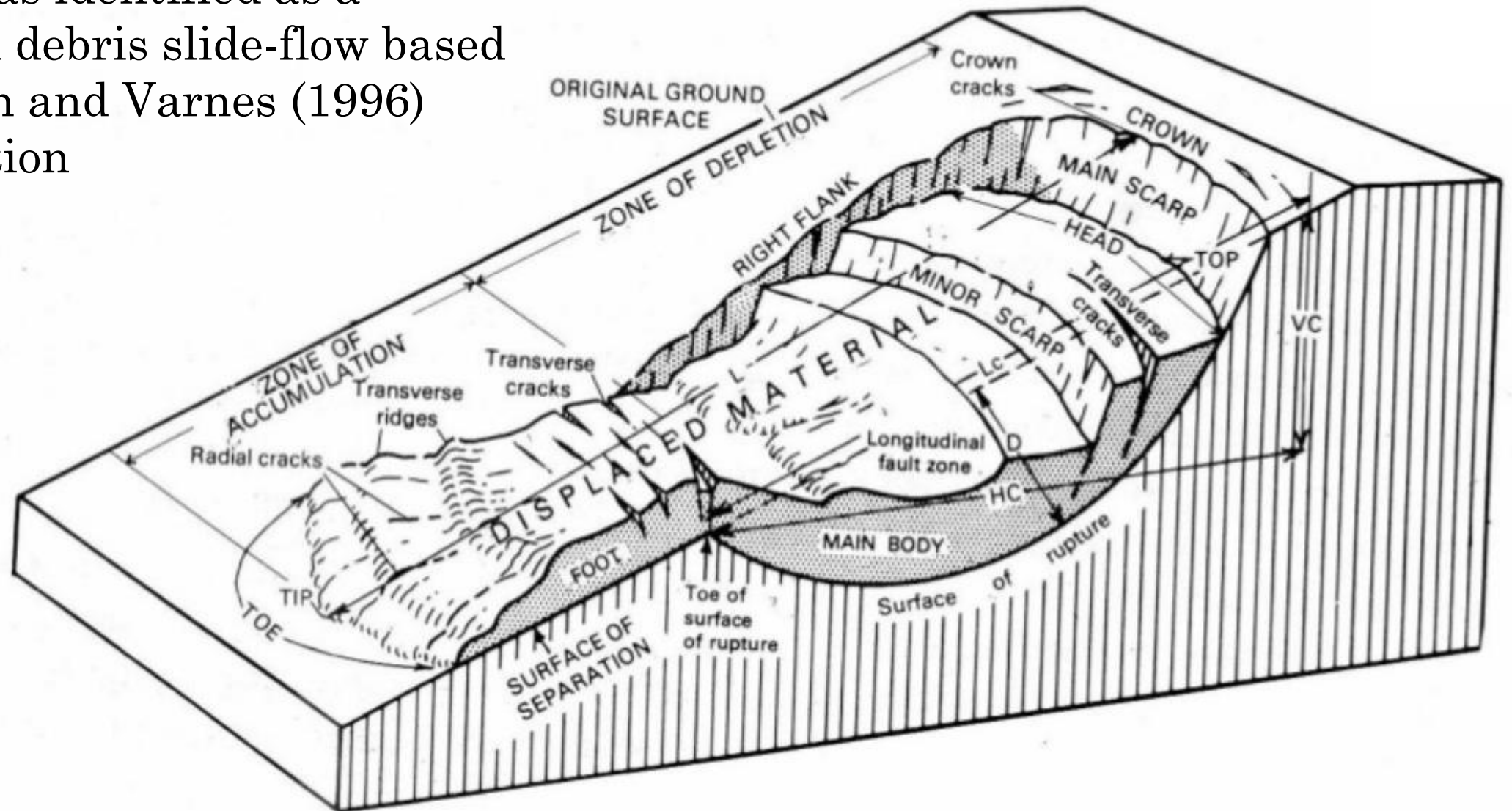
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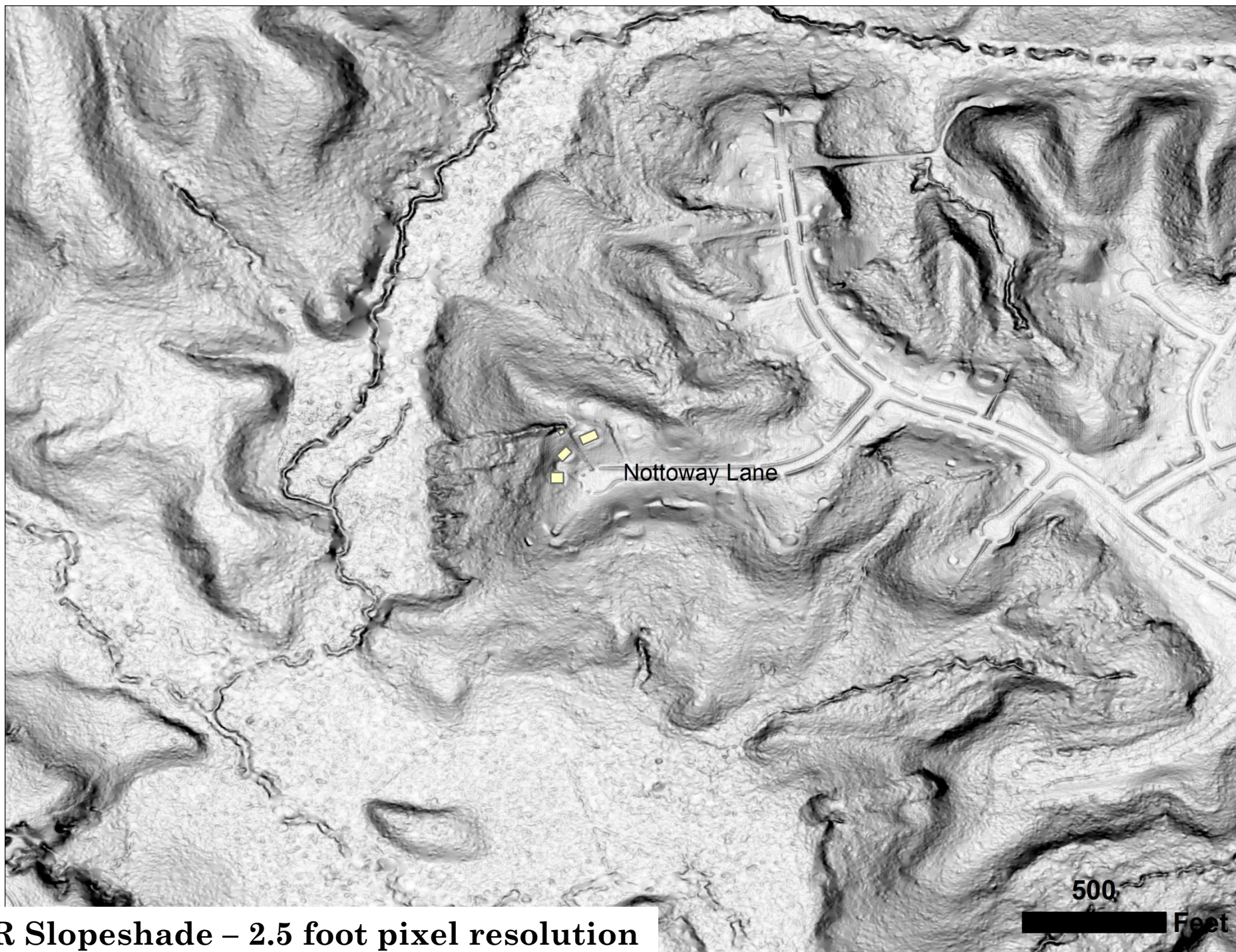


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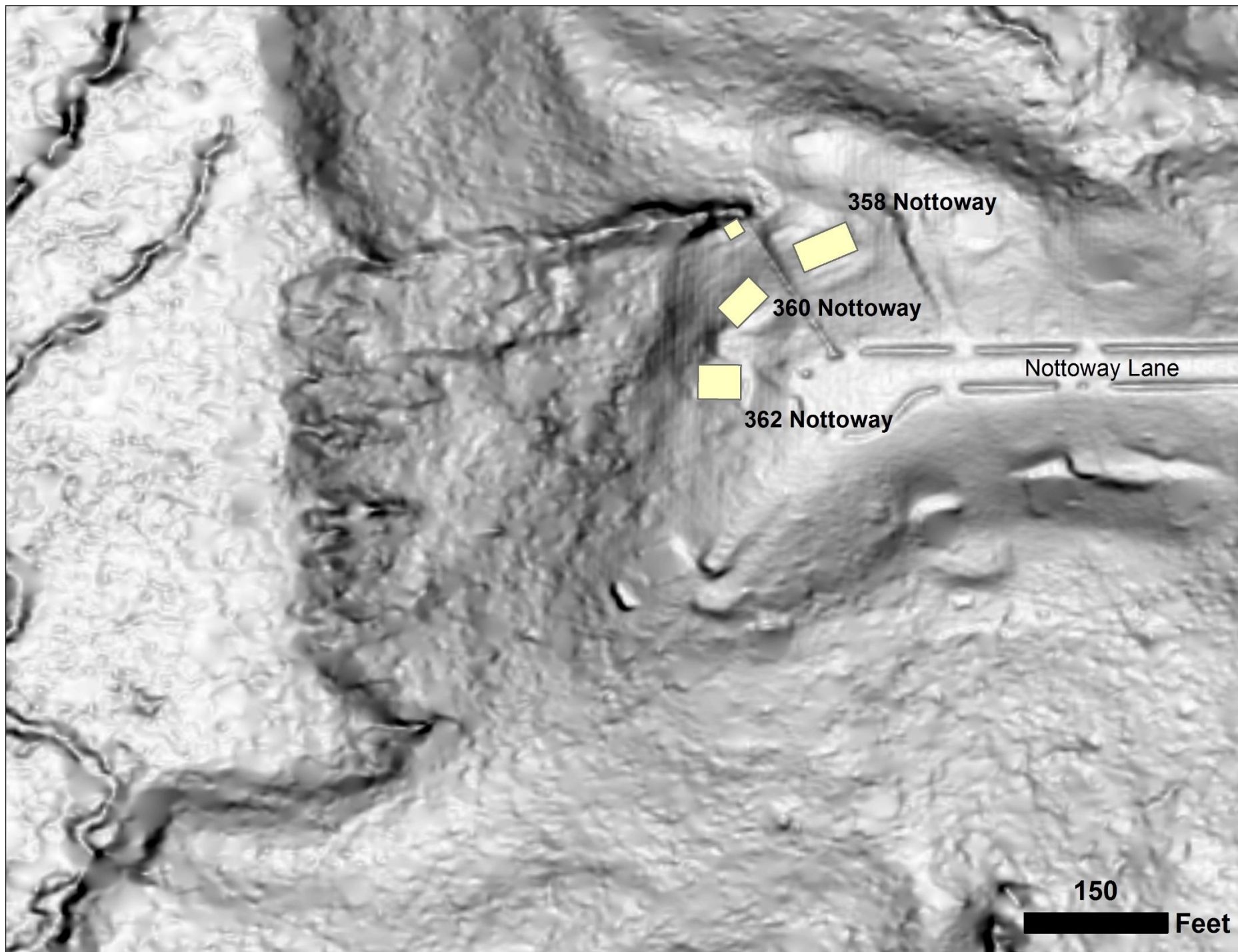


- Based on this evidence, the feature was identified as a rotational debris slide-flow based on Cruden and Varnes (1996) classification



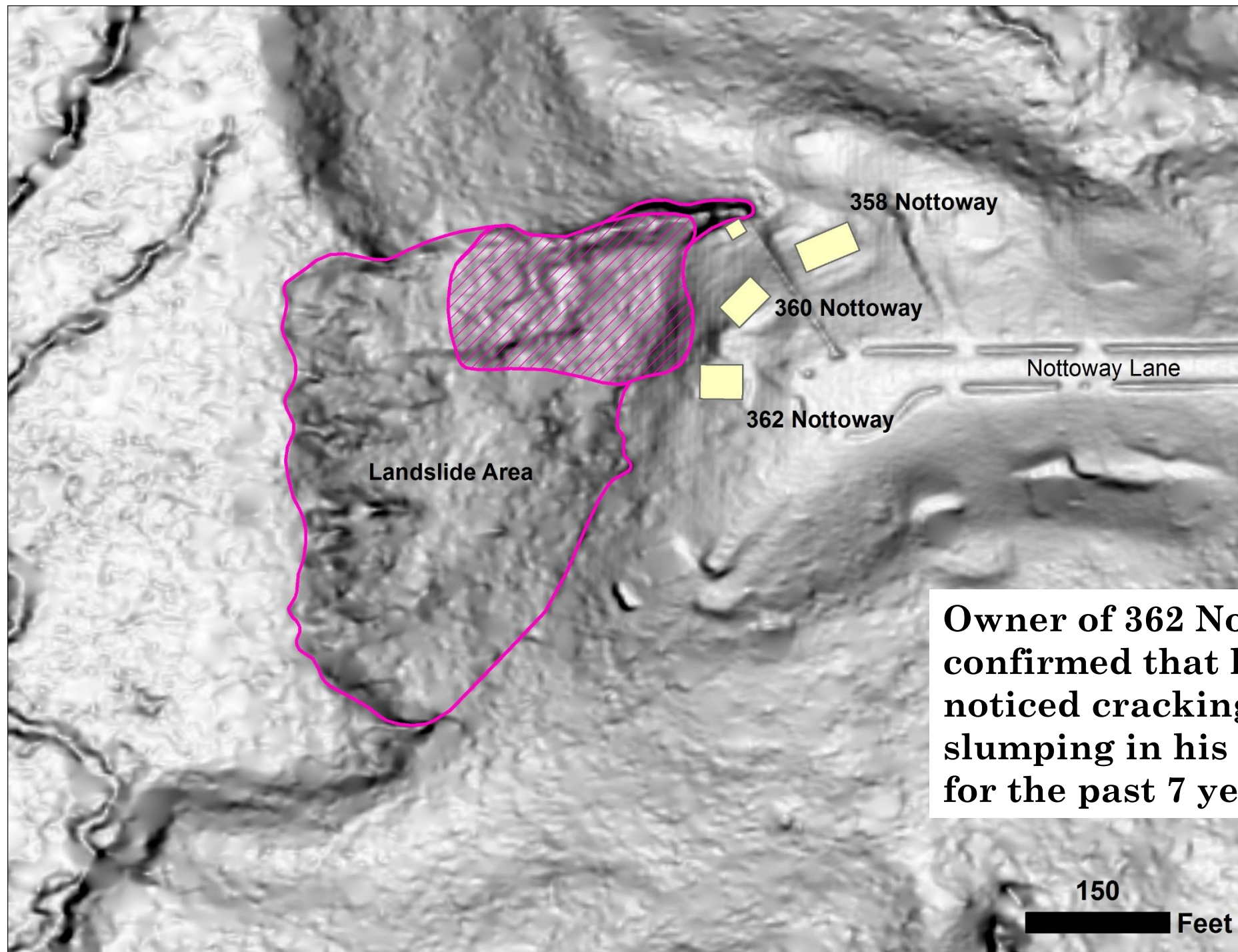


2011 LiDAR Slopeshade – 2.5 foot pixel resolution



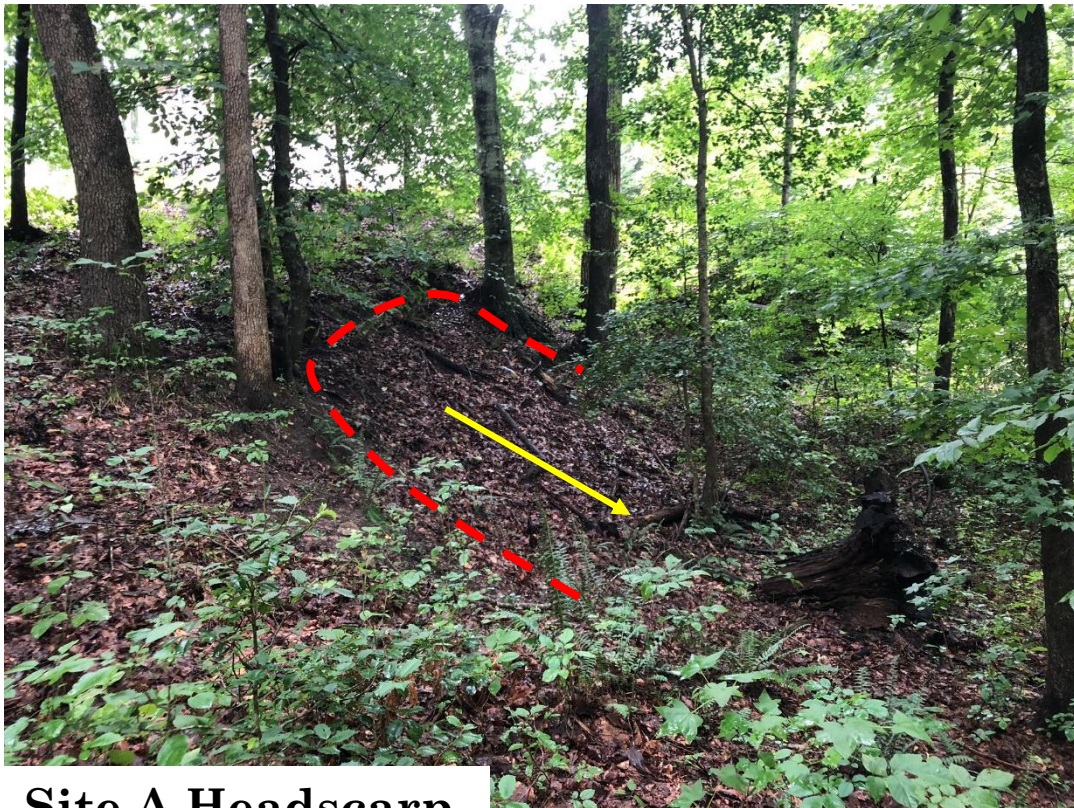
150

Feet

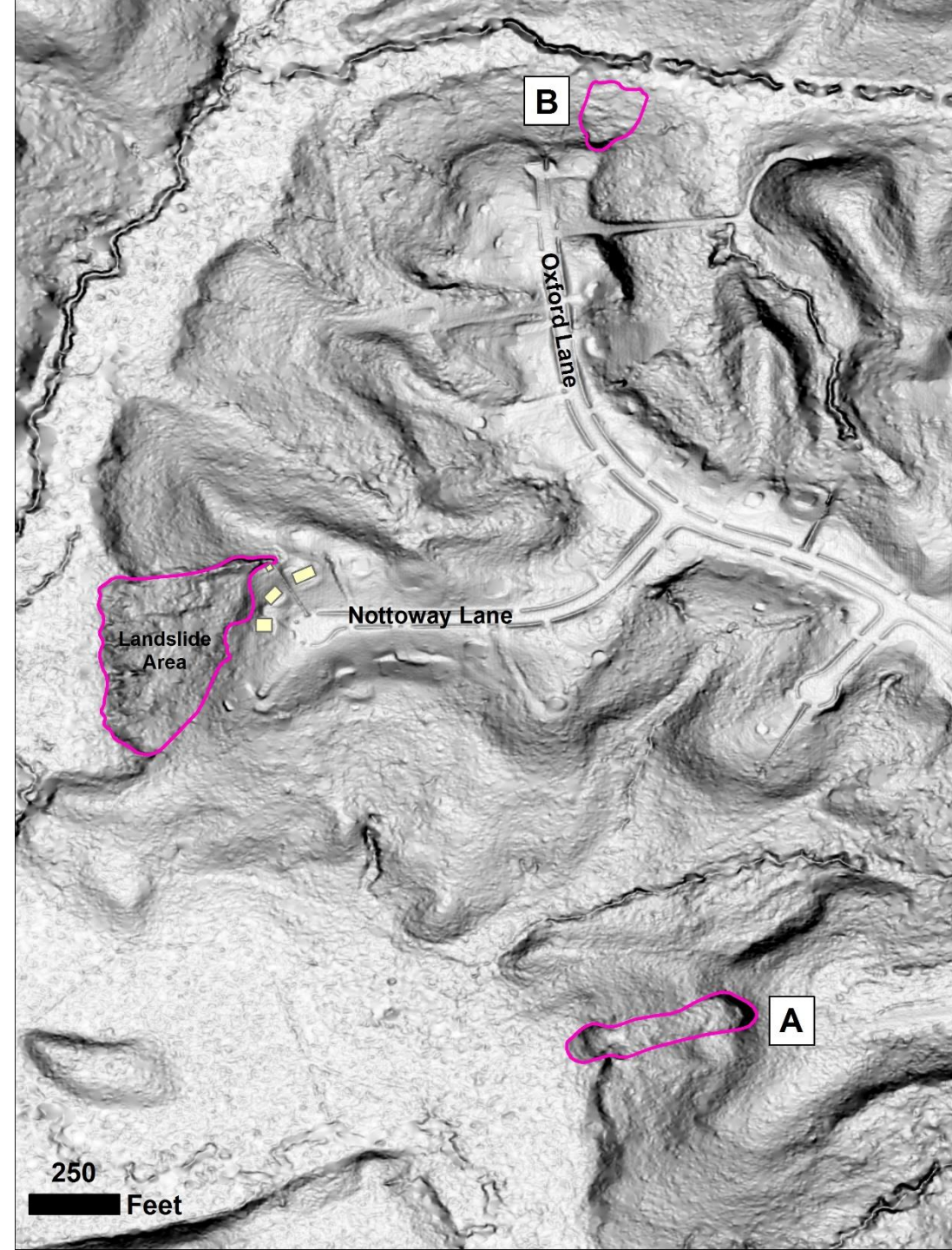


Owner of 362 Nottoway confirmed that he had noticed cracking and slumping in his backyard for the past 7 years.

- Revisited neighborhood July 25:
 - Site A = Debris flow
 - Site B = Debris slide
- Both had significant regrowth in the head scarps → landslides were older than 10 years
- Neither posed a threat to life or property

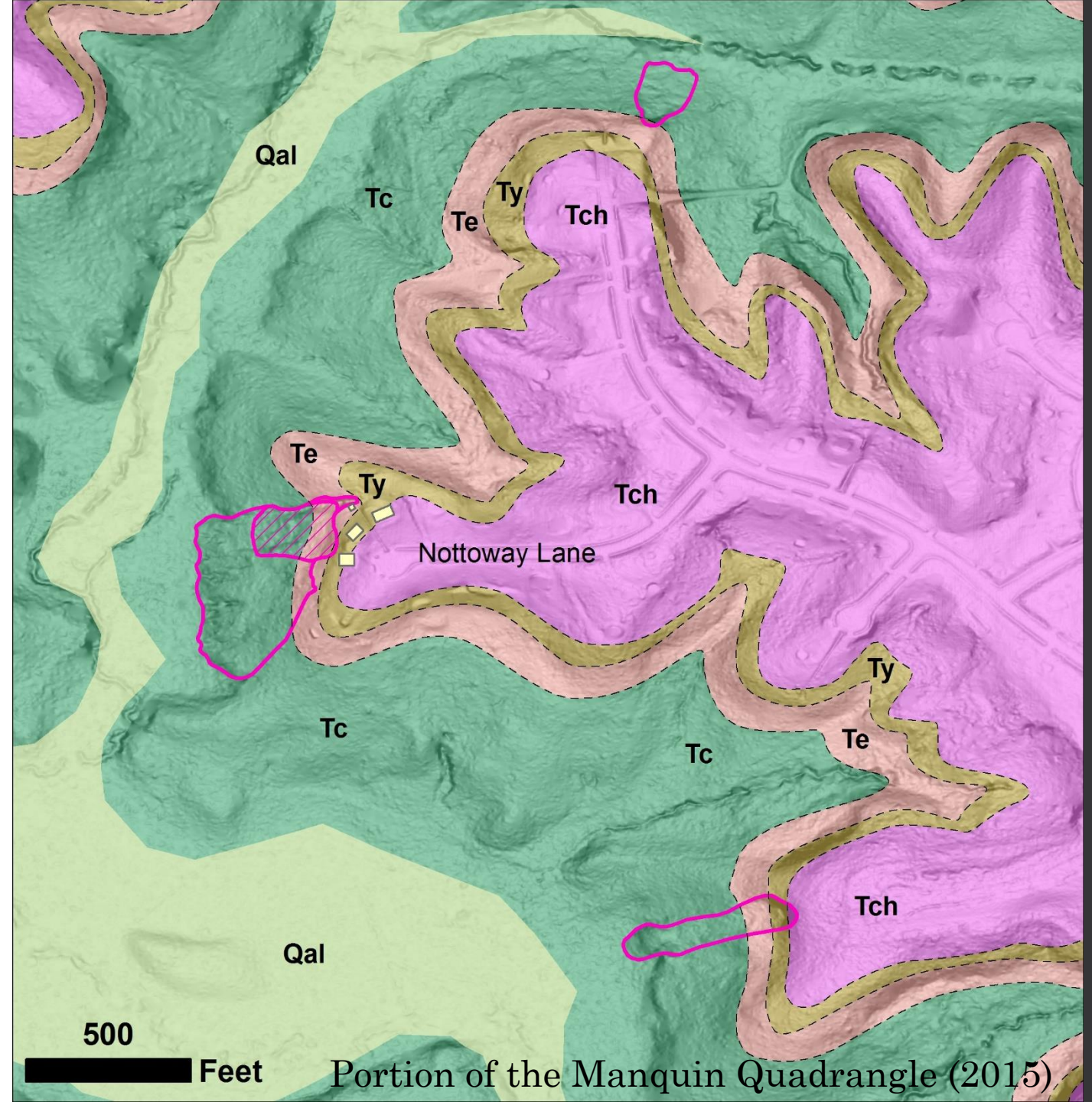


Site A Headscarp



- King William County is in the Virginia Coastal Plain
- Geologically mapped at 1:24,000 scale by DGMR in 2015
- Geological Units = gently dipping, unconsolidated marine and nearshore sediments from the Late Pliocene to Early Eocene

Tch	Cold Harbor Formation
Ty	Yorktown Formation
Te	Eastover Formation
Tc	Calvert Formation



- Stratigraphy of the landslide headscarp examined by DGMR and USGS on August 1
 - Cold Harbor – 0-8.9 ft
 - Yorktown – 8.9-18 ft
 - Eastover – 18 to base of headscarp

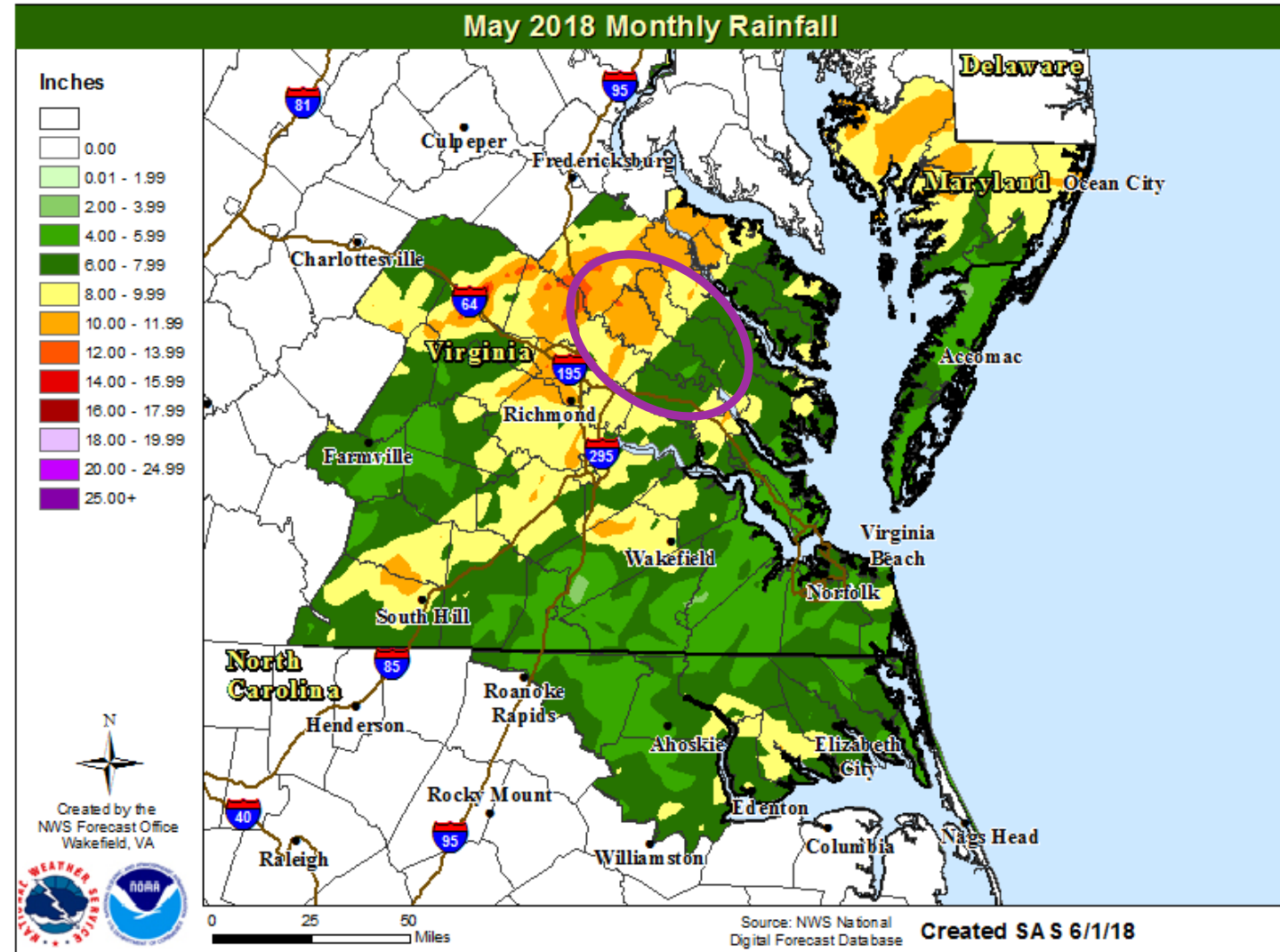


- Stratigraphy of the landslide headscarp examined by DGMR and USGS on August 1
 - Cold Harbor – 0-8.9 ft
 - Yorktown – 8.9-18 ft
 - Eastover – 18 to base of headscarp
- Eastover Formation – well-jointed, firm, silty clay that breaks easily along joint faces and fracture surfaces
 - Framboidal pyrite found on fresh surfaces
 - When exposing with hand shovel, groundwater readily flowed from fractures in the clay



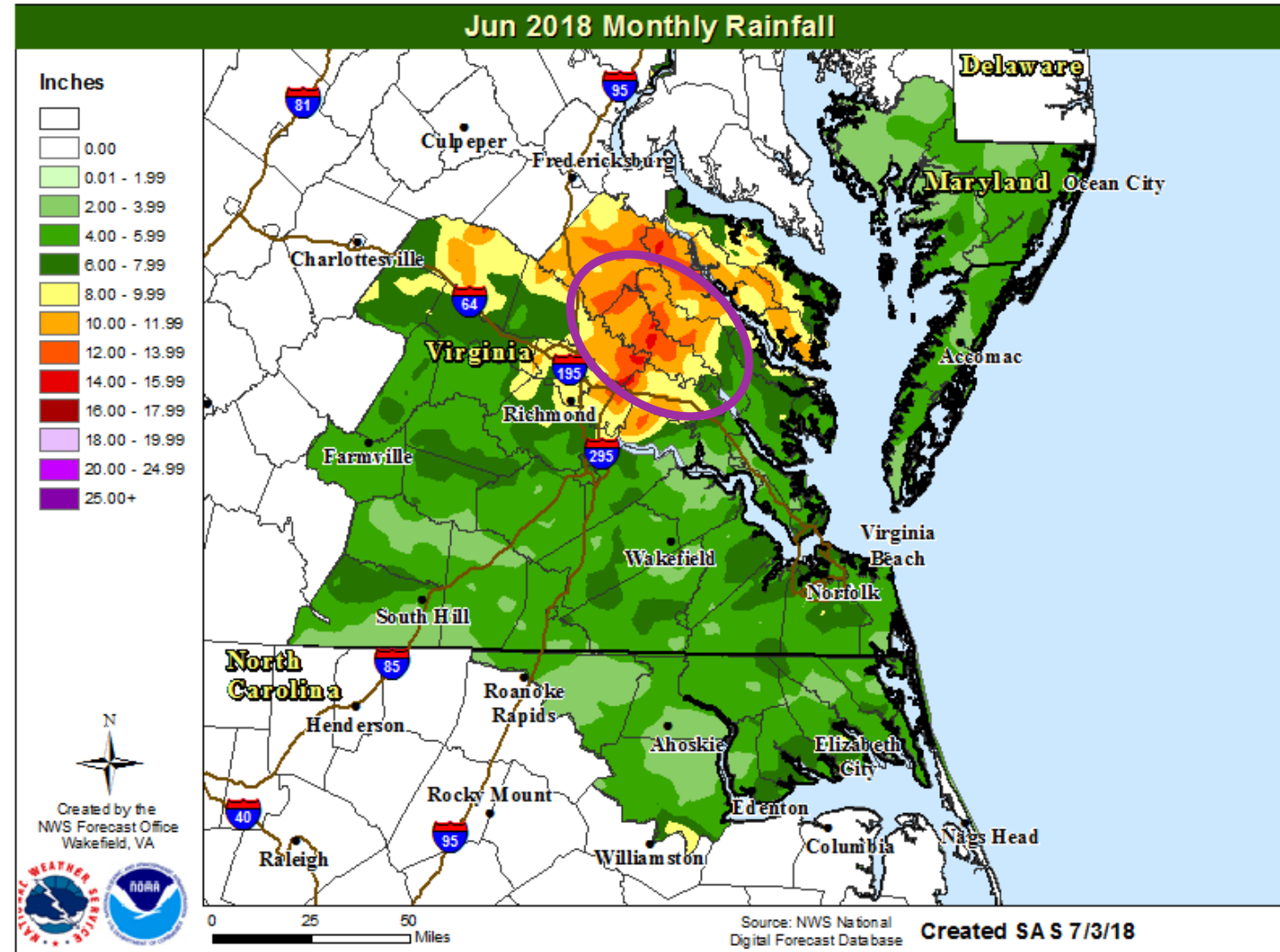
Discussion - Rainfall

- Precipitation was the likely cause of the Nottoway Landslide
 - May and June 2018 had been particularly wet; monthly precipitation totals 150-300 percent greater than normal



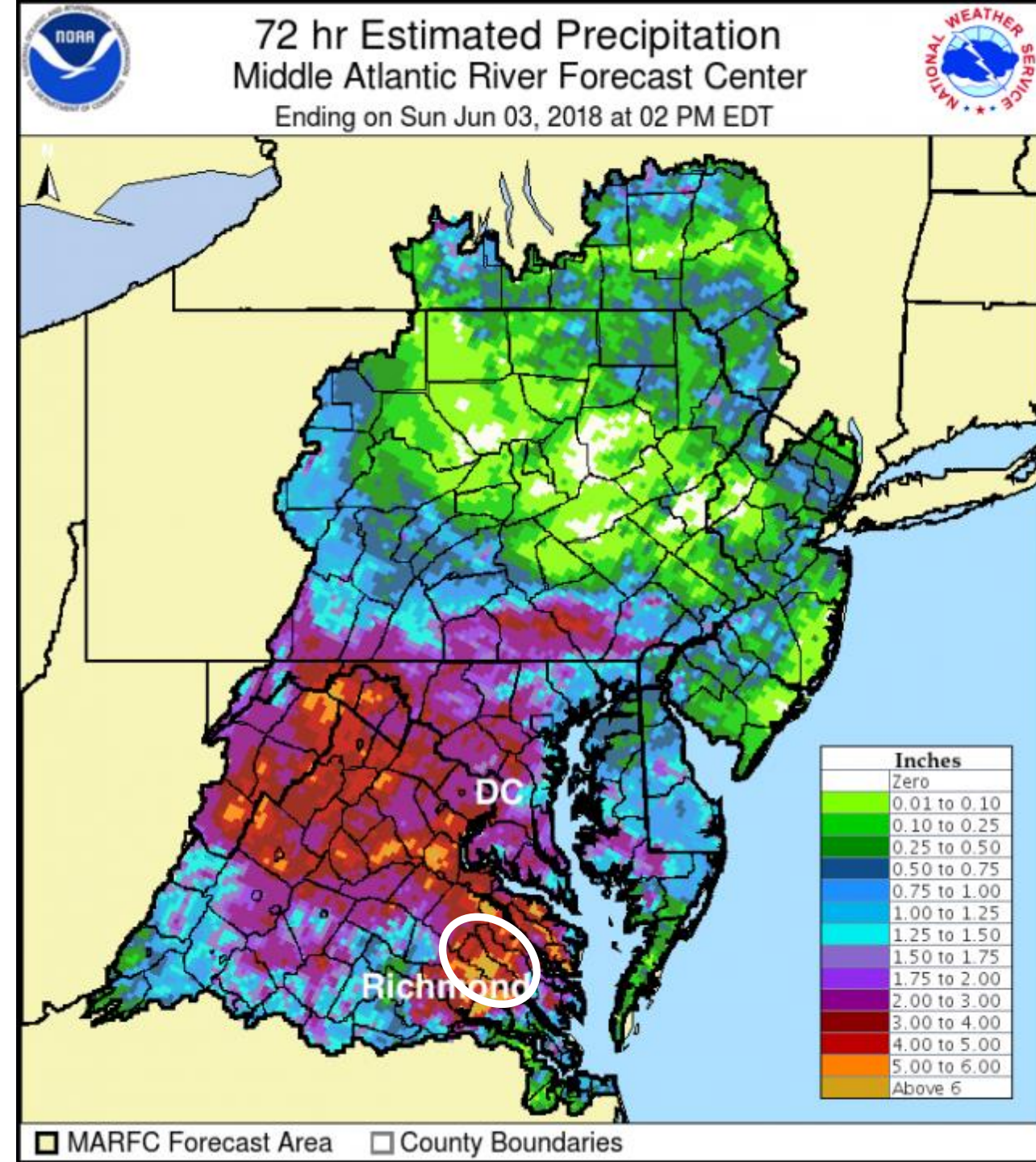
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Discussion - Rainfall

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 - May and June 2018 had been particularly wet; monthly precipitation totals 150-300 percent greater than normal
- Between June 2-4, a stationary low-pressure system produced 2-4 inches of rain across Northern and Eastern Virginia
 - Heavy rain early on June 3 (3.9 in 24-hours by the nearest rain gauge) likely triggered the initial failure
- From June 20-22, thunderstorms along a stationary front also produced significant rainfall → triggered additional downslope movement



Discussion - Rainfall

- Storm water runoff also contributed significantly to the slide and probably accelerated the reactivation of the slope
 - Concrete-lined storm drain between 358 and 360 Nottoway drains into the right-lateral flank of the landslide
 - Driveways between 360-362 Nottoway provided conduits for rainwater



Discussion - Geology

- Rupture surface of the Nottoway landslide probably occurred in the clay-rich Eastover along a fracture surface, or at the contact between the Eastover and the Yorktown
- Similar to the 2004 Chimborazo Hill landslide in Richmond
 - Rotational-translational debris slide
 - Rupture surface within the Eastover with numerous joints and fracture sets
 - West-facing slope

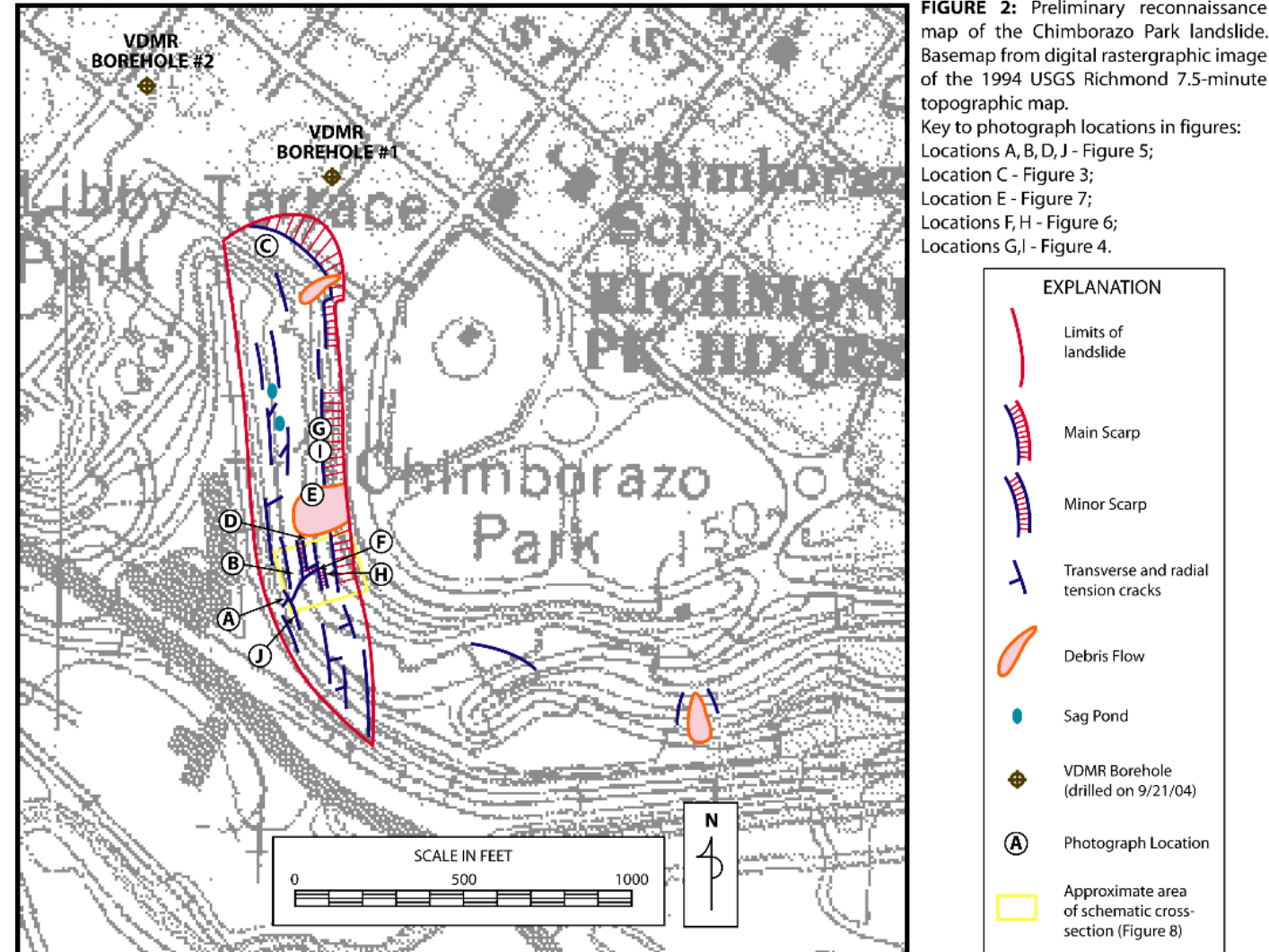




Figure 3: Panoramic photograph, panning from the north (left side) to east (right side) of the Chimborazo Park playground portion of the landslide, taken on September 21st, 2004. Photograph is from Location “C” in Figure 2. Notice the successive layers of fill in the main scarp on the left side of the photograph. “Natural ground” crops out along the scarp in the trees behind the fence on the far right side of the photograph. Also note the large tree behind the fence that leans back toward the main scarp, signaling that rotational slumping was a contributing mechanism for failure in this part of the landslide.

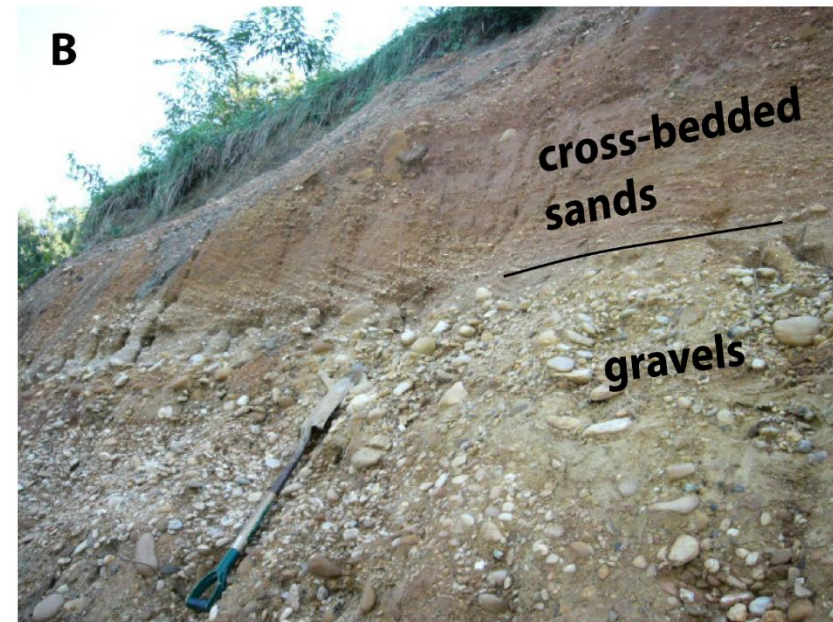
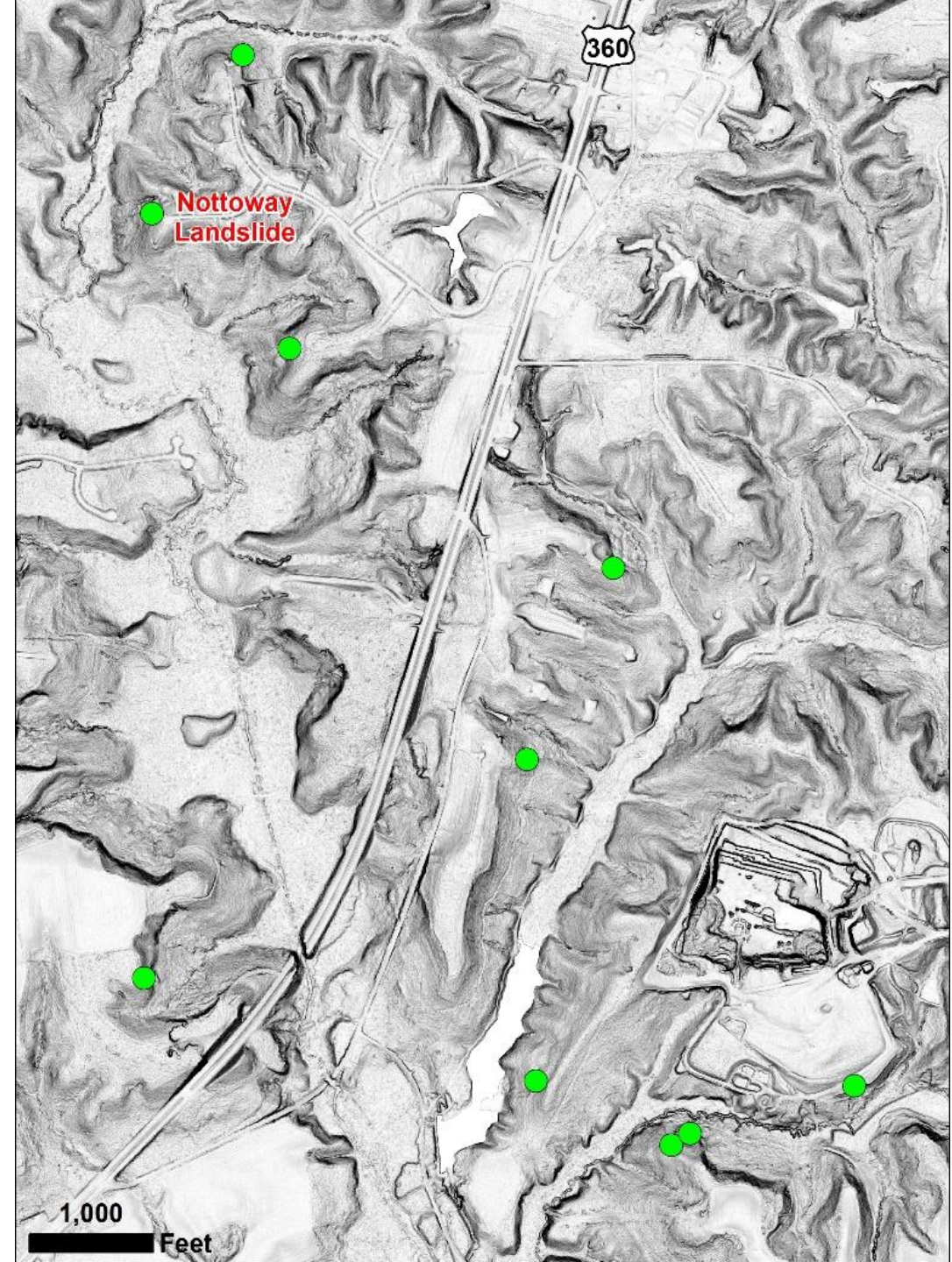


Figure 4: Photographs of the main scarp on the west slope of Chimborazo Hill. **A:** Photograph, looking southeast, of the fresh exposures of Yorktown/Bacons Castle Formations (sand and gravel layers) above Eastover marine clays in the main scarp. Photograph is from Location “G” in Figure 2. Shovel is approximately 3.5 feet long. **B:** Photograph, looking northeast, of the fresh exposures of Yorktown/Bacons Castle Formations (cross-bedded sand and gravel layers) in the main scarp. Eastover Formation crops out just below shovel handle. Photograph is from Location “I” in Figure 2.

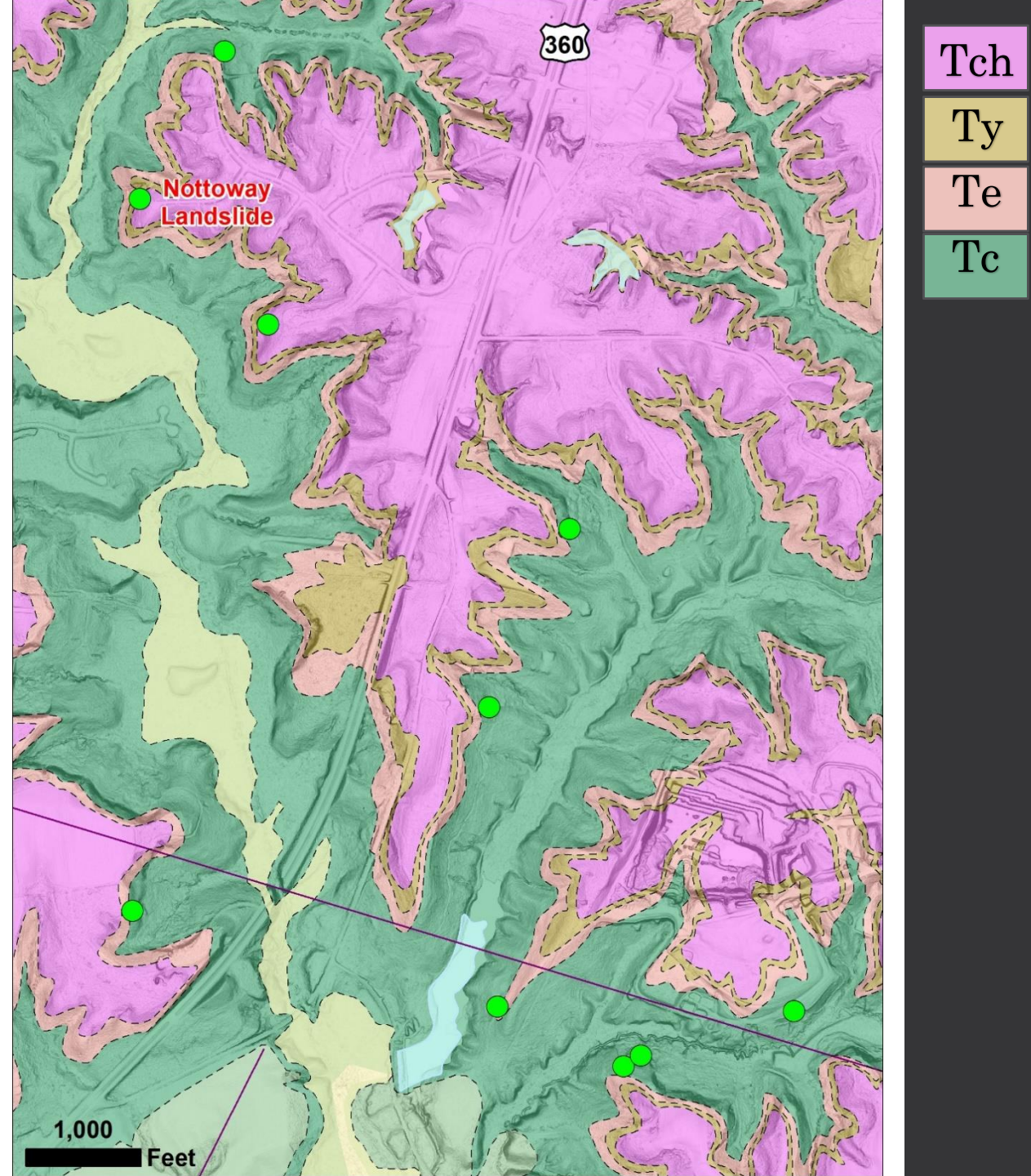
Future Work

- The Eastover Formation appears to be particularly prone to initiating landslides, especially during heavy rain events
- A first pass through the LiDAR in the immediate vicinity of the Nottoway Landslide identified numerous other debris slides
- Completing a comprehensive landslide inventory for this area using the 2.5-foot LiDAR will be crucial first step to identify areas that are a greater threat to public safety



Future Work

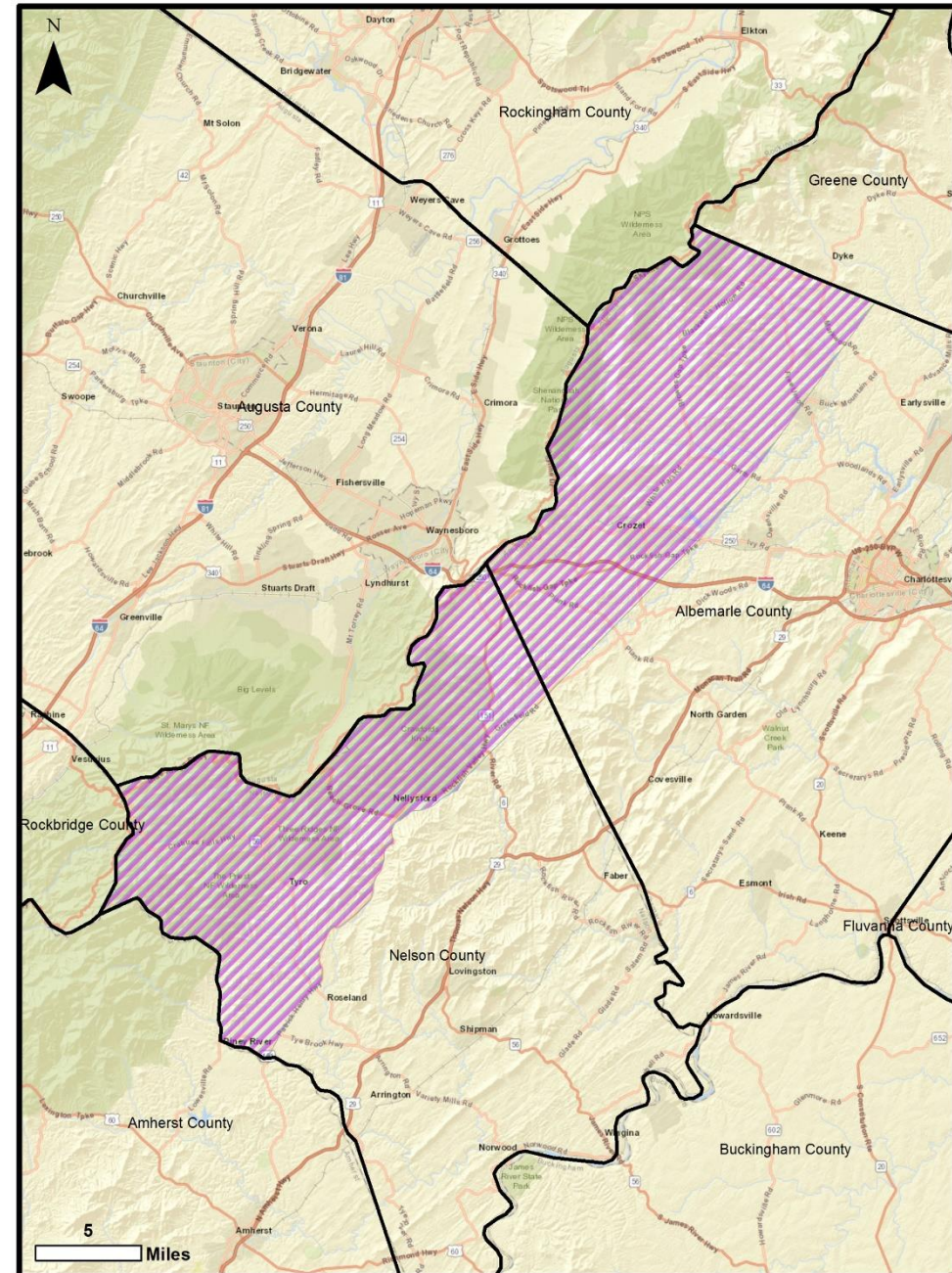
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FEMA Landslide Hazard Mapping Project Albemarle and Nelson Counties 2019-2020



Western Albemarle and Nelson Counties



Thanks!



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Visit our website:
<https://www.dmme.virginia.gov/dgmr/landslides.shtml>